

WHAT IS CLAIMED IS:

1. An automatic axle engagement system comprising:
  - a power source producing an output torque via a power source output shaft;
  - a front drive axle having at least first and second wheels selectively driven by said power source under predetermined conditions;
  - a rear drive axle having at least third and fourth wheels driven by said power source;
  - a transfer case having an input shaft coupled to said power source output shaft, a rear axle output shaft coupled to said rear drive axle, and a front axle output shaft for selectively coupling to said front drive axle;
  - a plurality of sensors determining rotational speeds of said first, second, third, and fourth wheels; and
  - an electronic control unit for comparing the rotational speeds measured by said sensors to determine if there is wheel slippage and initiating a shift to drivingly engage said front drive axle if there is wheel slippage by controlling said output torque to bring rotational speeds of said input shaft and said rear axle output shaft within a predetermined speed range.

2. A system according to claim 1 wherein each of said wheels includes a wheel brake controlled by said electronic control unit and wherein said electronic control unit simultaneously controls said output torque and generates a braking signal to actuate said wheel brakes to bring said input shaft and said rear axle output shafts within said predetermined speed range to allow said front axle output shaft to be coupled to said front drive axle.
3. A system according to claim 1 wherein said electronic control unit prevents driving engagement between said front axle output shaft and said front drive axle if said input shaft and said rear axle output shaft are not within said predetermined speed range.
4. A system according to claim 1 wherein said electronic control unit disengages said front drive axle from said front axle output shaft when said electronic control unit determines there is no wheel slippage.

5. A transfer case assembly comprising:
  - an input shaft for receiving an engine output torque;
  - a rear axle output shaft coupled to said input shaft via a gear assembly;
  - a front axle output shaft selectively coupled to said input shaft with a clutch mechanism; and
  - a controller for activating said clutch mechanism to couple said front axle output shaft to said input shaft during wheel slippage by controlling said output torque to bring said input shaft and said rear axle output shaft both within a predetermined rotational speed range.
6. An assembly according to claim 5 wherein said controller controls braking forces to bring the rotational speed of said rear axle output shaft within said predetermined rotational speed range prior to activating said clutch mechanism.
7. An assembly according to claim 6 wherein said controller simultaneously controls said engine output torque and said braking forces to bring the rotational speed of said rear axle output shaft and said input shaft within said predetermined rotational speed range prior to activating said clutch mechanism.
8. An assembly according to claim 7 wherein said controller activates said clutch mechanism to disengage said front axle output shaft from said input shaft when there is no wheel slippage.

9. A method for coupling a transfer case to a front drive axle during wheel slippage to achieve all wheel drive comprising the steps of:

- (a) coupling an input shaft of the transfer case to a power source producing an output torque;
- (b) coupling a rear drive axle having a braking mechanism to a rear output shaft of the transfer case;
- (c) sensing wheel slippage;
- (d) controlling at least one of the output torque or braking mechanism to bring the input shaft and the rear output shaft within a predetermined speed range; and
- (e) coupling a front output shaft of the transfer case to a front drive axle to achieve all wheel drive when the input shaft and the rear output shaft are within the predetermined speed range.

10. A method according to claim 9 including determining if the input shaft and the rear output shaft are both within the predetermined speed range prior to step (d) and eliminating step (d) if the input shaft and the rear output shaft are both within the predetermined speed range.

11. A method according to claim 9 wherein step (d) includes controlling only the output torque.

12. A method according to claim 9 wherein step (d) includes controlling only the braking mechanism.

13. A method according to claim 9 wherein step (d) includes simultaneously controlling both the output torque and the braking mechanism.
  
14. A method according to claim 9 including:
  - (f) decoupling a front output shaft of the transfer case from the front drive axle when there is no wheel slippage.